April, 1949

AIC-226

THE FROTH FLOTATION PROCESS FOR CLEANING VINED GREEN PEAS

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THE FROTH FLOTATION PROCESS FOR CLEANING VINED GREEN PEAS

A. M. Neubert

The froth-flotation process for cleaning vined green peas for canning and freezing has proved valuable. It reduces inspection and sorting labor, and saves large tonnages of peas that would otherwise be discarded because of heavy contamination with foreign material. It is particularly useful in removing nightshade berries, tarweed seed, dogfennel blossoms, and certain other weed parts from vined peas. Use of the process improves the quality of the smaller sieve sizes through removal of splits and skins. While capable of removing some thistle buds, the process does not remove thistle buds that cannot be removed by conventional flotation washers and air cleaners. Removal of the remaining thistle buds by hand sorting of froth-flotation-cleaned peas is simplified because of their freedom from splits, skins, and other foreign material.

This circular presents working instructions for the construction, installation, and operation of froth-flotation equipment suitable for use in cleaning vined green peas. The information presented is intended primarily for plant superintendents and personnel responsible for the construction and operation of this equipment. Readers interested in technical consideration of the process are referred to published articles.1,2/

FROTH FLOTATION EQUIPMENT

Equipment necessary for the froth-flotation process consists of a treater, a separator, and an auxiliary emulsion reservoir. Each of these units operates separately and requires a separate emulsion-circulating pump. The treater receives washed and drained raw peas from the preparation line, wets them with treater emulsion, drains off the emulsion, and delivers the treated peas to the separator. The separator classifies the peas and foreign material into sinkers and floaters on the basis of differences in wettability. The sound peas (sinkers), flowing from the separator by a gravity outlet, are drained from the separating emulsion, rinsed with cold water and returned to the preparation line. Foreign material and debris (floaters) are carried over a weir by the separating emulsion and are discarded into a sewer after the separating emulsion has been recovered. The auxiliary emulsion reservoir is used to prepare and store emulsion for use in replenishing the emulsion in the separator and treater during continuous operation. One auxiliary emulsion reservoir can serve several treater-separator units. Drawing C-236 shows the arrangement of this equipment in flow-sheet form.

1/ A. M. Neubert and M. K. Veldhuis, Cleaning Vined Canning Peas by Froth Flotation, Food Indus. 17(5):494-497, May, 1945.

2/ A. M. Neubert, Using Froth Flotation to Clean Vined Canning Peas, Food Indus. 19(6):769-772, June, 1947.

Treater: To obtain efficient separation of peas from foreign material by the froth-flotation process, it is necessary first to condition the surface of the peas. This is conveniently accomplished by circulating the peas in an emulsion, similar to that used in the separator, in a hydraulic conveyor system (Dwg. C-236). The treating solution recovery reel and storage tank for treating solution (see drawing D-234, side and end elevations) become a part of this conveyor system. A pump is connected to the tank outlet and delivers the treating solution to a flume or pipe, which conveys the peas to the treating-solution recovery reel. A half-inch stand-pipe, supplied with funnel and valve (see drawing D-236) is placed on the suction side of this pump for use in preparing the treating solution. A hydraulic elevator pump may be used where it is necessary to elevate the peas to the separator. The treating emulsion is kept in a separate system from the separator emulsion and should be thoroughly drained from the peas before they are delivered, by the treating-solution recovery-reel dump bucket, to the separator.

Separator: The capacity of separator units depends on their width. The drawings attached provide for a separating capacity of 3 tons of peas per hour at a uniform rate of flow. Smaller units can be constructed by reducing the width of the machine, provided the dimensions for lengths and the various slopes are maintained. Capacities can be expected in proportion to width; that is, a 7.5-ft. width will handle about 3 tons per hour, a 5-ft. width 2 tons per hour, and a 2.5-ft. width 1 ton per hour. A separator 2.5 feet wide requires only one sinker outlet and one sinker reel.

The 7.5-ft-wide separators have given best results when equipped with a semi-open or open impeller centrifugal pump having a capacity of 1000 gpm. of water when operated at 750 rpm. against a 10-ft. head. Pumps of this capacity are usually supplied with a 6-inch inlet and 6-inch outlet. The pump should be powered with a 10-hp. motor, connected to the pump by means of pulleys so that the pump operates at about 1500 rpm. Separators 5.5 ft. wide have been operated successfully with a similar pump having a capacity of 900 gpm. when operated at 740 rpm. against a 10-ft. head. Adequate capacities are obtained by driving the pump at about 1140 rpm. with a 5 or 7.5 hp. motor. Determination of the best speed for the circulating pump is described under "Operation of Froth Flotation Equipment."

Auxiliary Reservoir: Peas passing through the froth-flotation system during continuous operation deplete the oil from the emulsions, particularly in the treater. Replacement of this oil is conveniently accomplished by continuously adding a fresh emulsion of double oil content to the treating system during operation. An auxiliary reservoir (Dwg. C-236) is used to prepare and store this fresh emulsion. A circulating pump, supplied with a half-inch standpipe, funnel, and valve on the suction side, is used to prepare, agitate, and deliver this fresh solution to the treater. The reservoir should hold fresh emulsion sufficient for six hours' operation (about 10 gallons per ton of peas). One auxiliary reservoir can be used for supplying several flotation units. A quarter-inch pipe should be used to deliver the fresh emulsion to the treater and separator, and the pump should be by-passed to the reservoir in such a way that the solution is continuously agitated.

Automatic Regulator: Drawing C-236 shows the construction of a regulator suitable for automatic control of the separating properties of the separator solution. While not essential in the operation of the process, this regulator permits increased cleaning efficiency and eliminates the need for constant attention by the operator. Care must be used in constructing the regulator to eliminate friction, and it should be mounted in the separating bath in an area that is free from turbulence. All wiring, including the mercury switch, should of course be enclosed.

INSTALLATION

The froth flotation equipment can be installed in the line at any convenient point between the washer and the blancher. When peas are size-graded, it is frequently advantageous to install the separator after the size grader in such a way that those sieve sizes which do not require special cleaning can be by-passed directly to the blancher, thereby avoiding the necessity of having froth-flotation capacity equal to the plant or line capacity. The pea-delivery arrangement should be made versatile, so that any lot of peas requiring special cleaning can be diverted to the flotation unit and the cleaned peas returned to the line. The separator shown in drawing D-234 can be used to clean two sieve sizes or lots without mixing by supplying dual treater flumes and treating-solution recovery reels and dividing the sinker recovery flume. It should be possible to by-pass the flotation unit entirely, so that the line need not be interrupted during periods of repair or cleaning of the flotation unit.

OPERATION

Cleaning: The equipment must be clean and free from grease. It is usually necessary to scour new machines with soap and hot water to remove grease, flux, and other dirt accumulated during construction. The perforated sheets used in constructing the reels must be scrubbed free from oil and grease to permit drainage of the solutions. After each use, the entire equipment must be drained and washed free from scum and accumulated debris. Under no condition should the unit be operated for more than 6 hours between clean-ups.

Preparation of Separator Solution: (Volumes and amounts given are based on 7.5-foot unit, Dwg. D-234.) Fill storage tank for separator solution (Dwg. D-234, side elevation) with water. This tank, as drawn, will hold about 380 gallons. Open standpipe valve on suction side of separator circulating pump and start pump. When the water is returning to the tank through the sinker and floater discharges, the water level in the separator storage tank should just cover the pump inlet pipe to permit circulation. Do not add more water unless it is necessary to cover the pump inlet, because air, which will be incorporated in the solution, will increase its volume by as much as 20 percent and the reserve capacity of the tank is needed to contain this increase in volume.

Add 1 pint of stock detergent (1 part sodium lauryl sulfate paste and 1 part hot water, thoroughly mixed) to the water circulating in the separator. As soon as the solution begins to foam, pour 5-6 gallons of oil (based on 380 gallons of water) into the standpipe. A highly refined, deodorized mineral oil having an initial boiling point of about 400°F. and a final boiling point of about 500°F.

and a Saybolt viscosity of 30-35 at 100°F. is suitable. It is important that the oil be added through this standpipe after the detergent has been added, so that it will be emulsified by the pump. Do not stop the circulating pump after the oil has been added until ready to dump the solution for clean-up.

Adjustment of Separator Valves, Pump, and Manifold: Several adjustments must be made on the separator during the initial run. After these are once made, this step can be ignored. After the machine has been started and the detergent and oil added, slowly close the adjustable sliding gate (D-234, side elevation) in the storage tank for separator emulsion until the pressure gauge on the manifold delivery pipe reads about 3 pounds. Open the valve on the spreader flume supply pipe sufficiently to give the flow necessary to carry the treated peas to the separator. (Note: Leave the standpipe valve wide open whenever the pump is in operation.) When the pressure has been reduced to 3 pounds, note the flow of emulsion from the sinker discharge pipes and over the floater weir. The solution should flow over the discharge weir at a depth of about a half inch and the sinker discharge pipes should have sufficient flow to carry the peas out of the separator. If the flow is not sufficient for these purposes, the manifolds must be removed and additional holes drilled to supply the necessary flow (see Note 3, Dwg. D-234). Should the flow be greater than necessary, some of the holes in the manifold should be plugged. When the proper number of holes has been determined, the adjustable sliding gate should be readjusted to give the desired pressure.

When these adjustments have been made, the flow of air into the standpipe should be noted. If considerable suction is not observed, it is necessary to speed up the pump and further close the adjustable sliding gate until considerable suction is obtained at the standpipe.

Preparation of Treating Solution: Fill the storage tank for treating solution (Dwg. D-234, end elevation) with water (about 250 gal., which should be sufficient to fill the pumping system and treating flume). Start the treater circulating pump and add two-thirds of a pint of prepared detergent solution. Then open the standpipe valve and add 4 gallons of oil through the standpipe. When all the oil has been added, close the standpipe valve. An overflow pipe with valve is desirable to remove the solution accumulated from the incoming peas and from the auxiliary reservoir. This overflow pipe is conveniently located 6 to 8 inches above the bottom of the tank and drains to a gutter. After the treating solution is prepared, the overflow pipe should be opened. The only attention required by the treater during operation is the continual addition of oil by means of the auxiliary solution.

Preparation of Auxiliary Reservoir Solution: This solution is prepared in exactly the same manner as the separator and treater solution except that 3 gallons of oil are added for each 100 gallons of water used. Prepared detergent is first added at a rate of about one-fourth pint per 100 gallons. After the oil has been emulsified, the solution is delivered to the treater at a rate of about 10 gallons for each ton of peas cleaned. It is convenient also to pipe the auxiliary emulsion to the separator reservoir so that the separator-emulsion level can be maintained during operation.

Adjustment of Separator: After the solutions have been prepared and the entire system is in operation, the spray wash water in the sinker recovery reels is turned on and peas are started through the machine. In the first operation it is well to pass only a few peas at a time through the system while the final separator solution adjustment is made.

About 25 pounds of peas are passed through the machine and the sinker and floater fractions are inspected as they leave the machine. Normally, when the solution has been prepared according to directions, it will be found that most of the peas float with the waste. (If they do not, fresh solution should be prepared with about half the specified amount of prepared detergent.) Prepared detergent is then added to the separator solution, 1 to 2 ounces at a time at intervals of 2 to 4 minutes until most of the sound (uncracked) peas sink. Detergent is then added in smaller amounts until desired separation is obtained.

If too much detergent is accidentally added, nightshade berries and other debris will sink with the peas and cleaning will not be effective. When this condition is encountered, it becomes necessary either to dump the solution and start fresh or add water and oil to dilute out the excess detergent. During operation it is necessary to add additional detergent as required to maintain the desired separation.

Adjustment of Regulator: Several adjustments must be made on the regulator (C-236). The spring on the mercury switch lever should be so adjusted that it corrects the balance of the lever when the mercury has flowed to the end of the tube with the circuit open. This spring should exert no tension when the switch is horizontal (in the nearly closed position). The lever should be balanced in this position by means of counter weights. The detergent reservoir is filled with warm prepared detergent (1 part sodium lauryl sulfate paste to 1 part warm water) and the heater is turned on. It is necessary to keep this solution at about 90°F. to prevent precipitation. The needle valve is opened to allow detergent to pass at a fast drip. The adjustable vent is then raised or lowered so that about 1 ounce of detergent accumulates in the pipette when the solenoid valve is closed. This accumulated solution should flow freely when the solenoid valve is opened. The solenoid valve and detergent reservoir assembly are conveniently mounted on the edge of the separator so that the detergent is discharged into the separating emulsion.

Final adjustment of the regulator is made while the separator is in actual operation on peas. When the separating solution has been adjusted, by manually adding prepared detergent, to give the desired separation, lead shot is added to the weight cup until the float begins to sink. Additional shot is added slowly until the float rests on the supporting bracket, opening the mercury switch and closing the solenoid valve.

When peas begin to float, the regulator float will rise, closing the mercury switch which opens the solenoid valve and allows the measured detergent to flow into the separating solution. If the float does not sink in 2 minutes, the volume of detergent measured by the pipette should be increased by sliding the adjustable vent up. After a little experience the operator can adjust the separating solution by observing this float without the use of peas.

OPERATING DIFFICULTIES AND THEIR CORRECTION

The following list of difficulties occasionally encountered and methods for their correction are presented as a guide in the operation of froth flotation equipment. It is assumed that the equipment is in proper operating order and that the necessary solutions have been prepared and are being circulated as specified.

Sound peas float with debris:

Add prepared detergent to separator, 1 to 2 ounces at a time. Wait 2 minutes after each addition of detergent before inspecting results. One to two minutes are usually required for the detergent to act. If an automatic regulator is used, check its operation and open clogged tubes.

Nightshade and other debris sink with the sound peas:

Too much detergent is present in separator. It is necessary either to dump the separator solution and start fresh or dilute the separator solution with water and oil. Occasionally, the separator will give similar results after long periods of operation even though detergent has not been added for some time. This is caused by the contamination of the separator solution with plant juices, and the separator solution will usually have a green color. Correction is the same as for the addition of too much detergent. If this difficulty is frequently encountered, the raw peas must be more thoroughly washed and dewatered before reaching the treater. The treating solution recovery reel should be inspected to make sure treating solution is not being carried over into the separator.

Separation of peas from foreign material is not clean, even though separator solution is properly adjusted. Under this condition, considerable sound peas float and some debris appears in the sinker fraction:

Machine is probably being operated above capacity. Sudden or intermittent overloading gives poor results. It is important to provide a uniform feed.

Pressure drops below normal level on separator pressure gauge:

Excessive separator solution has been lost from system. Add more water and oil or draw fresh solution from auxiliary reservoir. Some installations use a float valve in this storage tank which is supplied directly from the auxiliary reservoir. For successful operation of the automatic regulator the pressure on the manifold must be constant.

Pressure rises above normal on separator pressure gauge:

First check the standpipe valve to be sure it is wide open. If this valve is in the normal open position and the adjustable sliding gate has not been moved, debris and foreign material have probably entered manifold. Remove manifold and clean out debris. Check screen over separator solution storage tank for possible leaks.

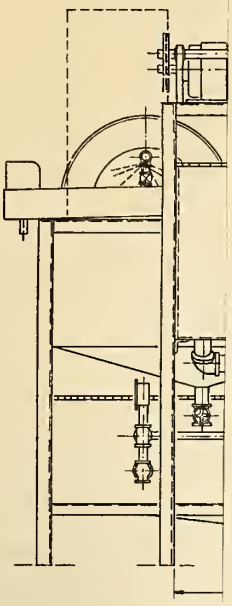
Floating debris does not go over weir but forms in eddies on surface of separators:

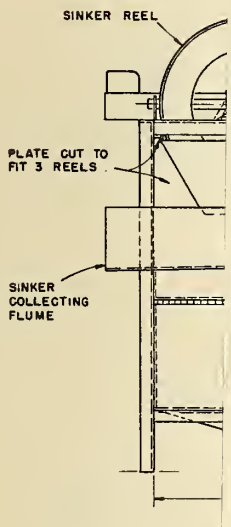
This condition can be corrected by suitably baffling the peas as they leave the spreader flume and by rearrangement of holes in the manifold. Turbulence on the surface of the bath may also be corrected by rearranging the holes in the manifold. The installation of several vertical solid metal sheets across the separator bath, which reach from about 1 inch above the top of the manifold to within 1.5 inches below the top of the separator solution, would aid in reducing turbulence and eddies.

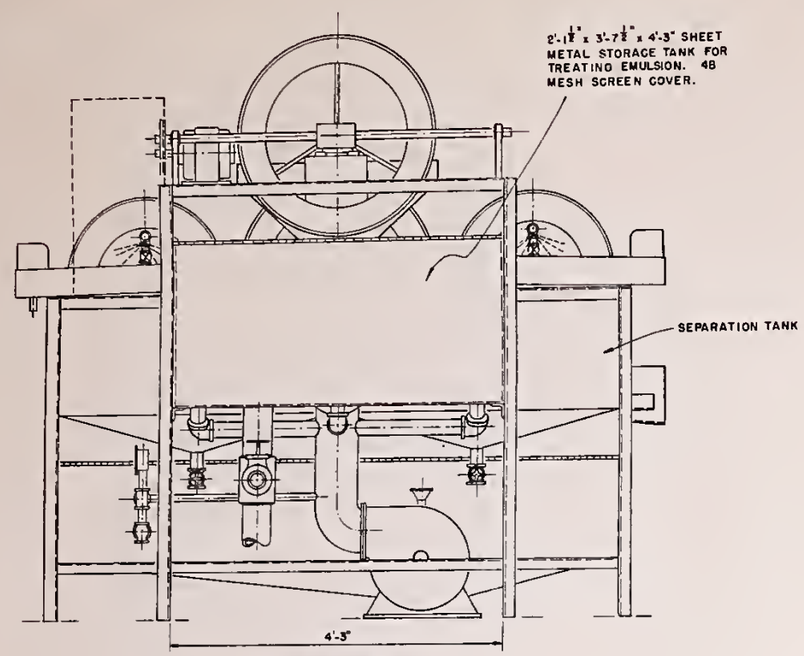
Automatic regulator fails to maintain desired separation:

Check float to be sure it is not binding. Check all valves and vents. These must be inspected frequently to make sure they have not clogged. Readjust valves and pipette.

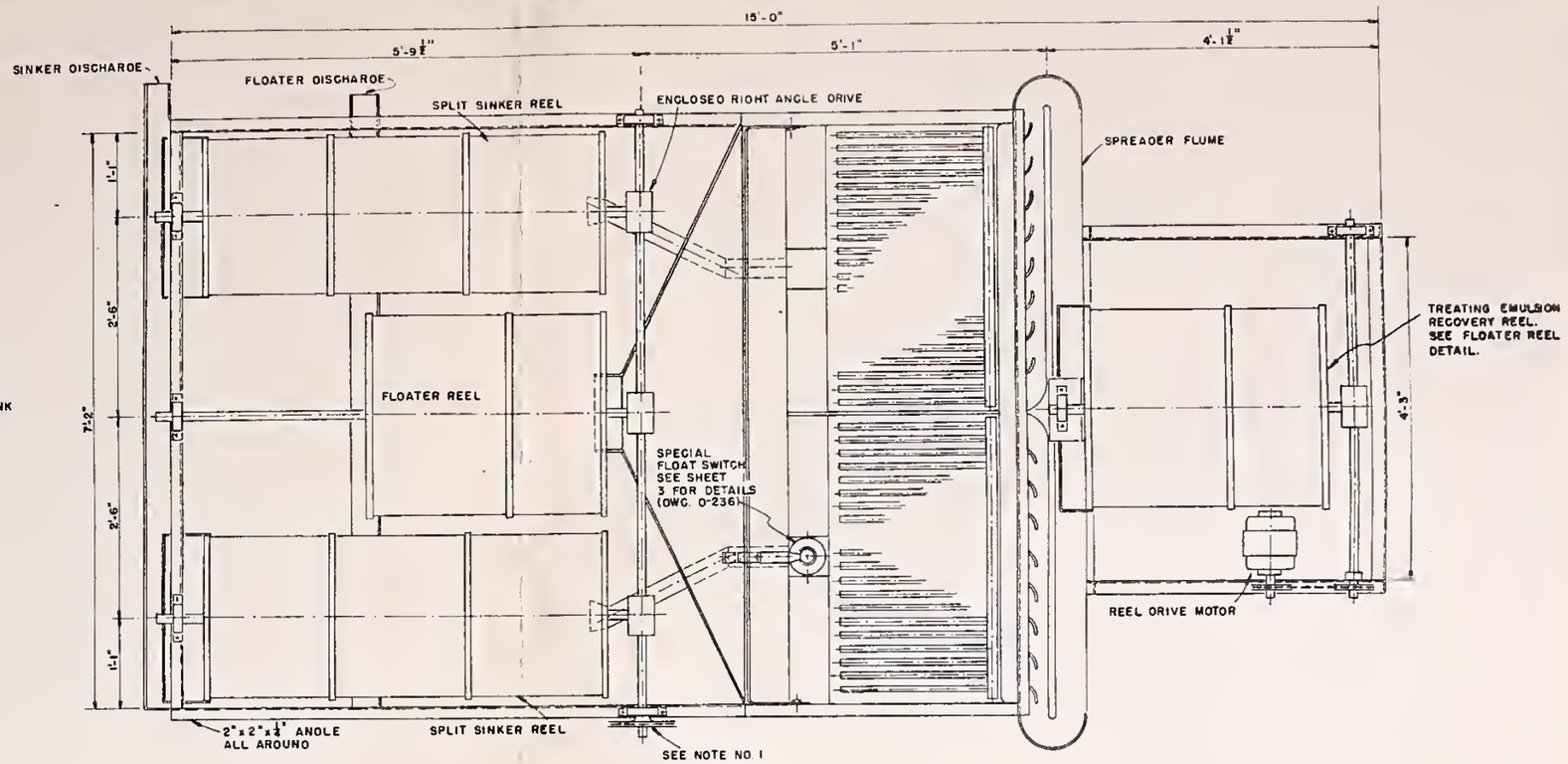
Three drawings are referred to in this circular: Drawings D-234, D-236, and C-236. If these drawings are not attached to the circular they can be requested by reference to their numbers.



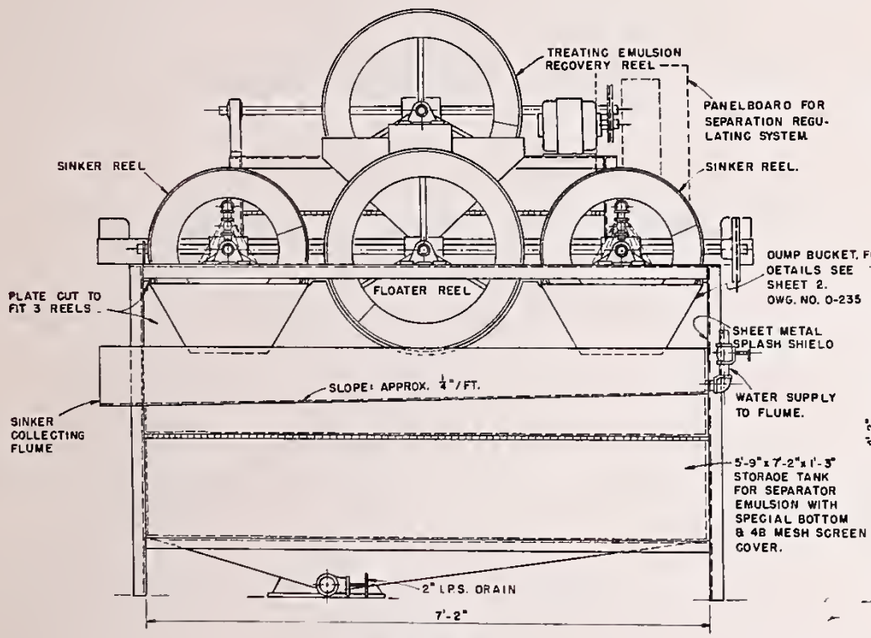

SINKER REEL
PLATE CUT TO FIT 3 REELS
SINKER COLLECTING FLUME



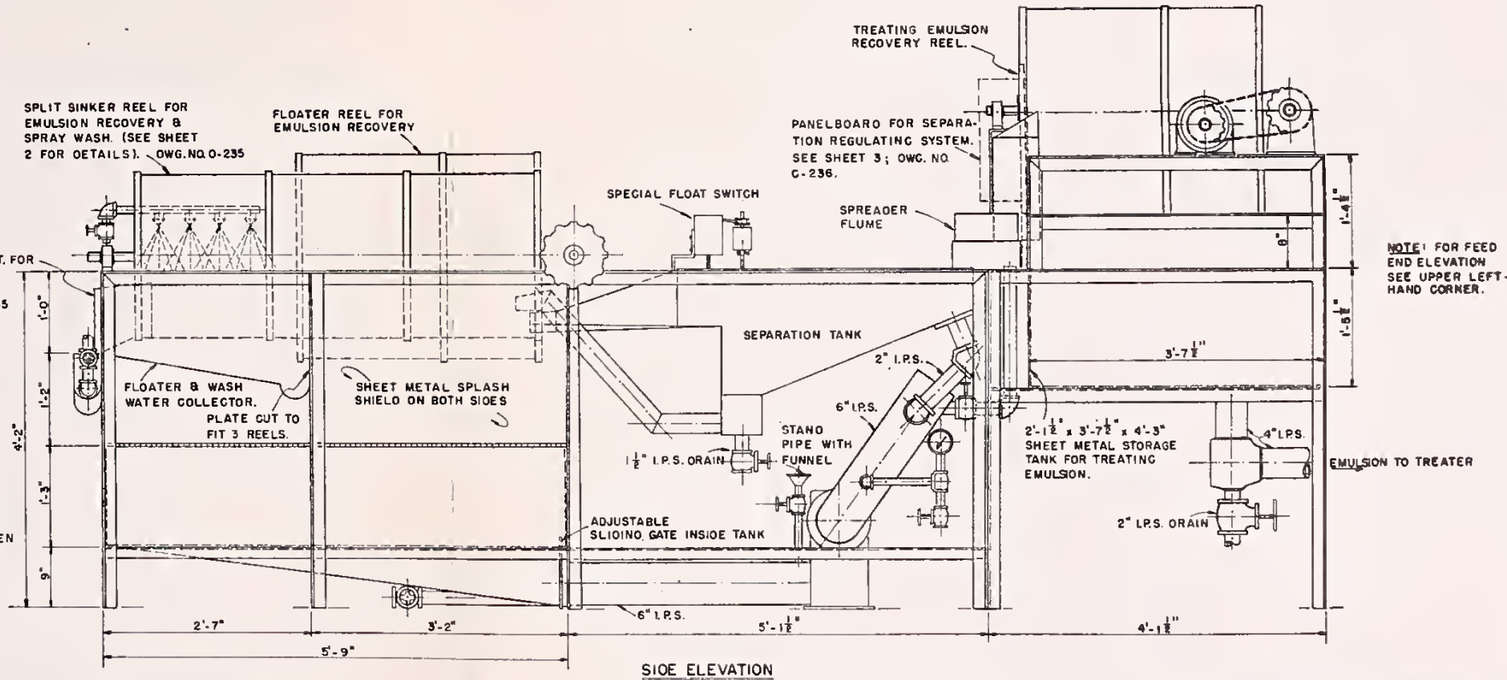
END ELEVATION
(FEED END)



PLAN



END ELEVATION
(DISCHARGE END)



SIDE ELEVATION

ASSEMBLY

SCALE: 1" = 1'-0"

NOTE 1. ALL REELS DRIVEN AT APPROX. 20 R.P.M. AND PROVIDED WITH A SLOPE (TOWARD THE DISCHARGE END) OF APPROX. 1/8" PER FOOT.
2. THE EQUIPMENT SHOULD BE CONSTRUCTED SO THAT THERE ARE NO POCKETS OR OBSTRUCTIONS WHICH WILL CAUSE PEAS TO LODGE.
3. DRILL EACH 1/2" DISTRIBUTOR PIPE WITH APPROX. 25-5/32" HOLES ON THE UNDERSIDE. ACTUAL NO. OF HOLES WILL BE DETERMINED BY THE PUMP SIZE. THERE SHOULD BE APPROX. 3 PSI PRESSURE DROP ACROSS DISTRIBUTOR DURING OPERATION. TO AVOID EDDIES, THE HOLES SHOULD BE MORE CONCENTRATED AT THE ENTRY END OF THE SEPARATOR.

MATERIALS OF CONSTRUCTION

IN GENERAL, CAST. IRON IS SATISFACTORY; STAINLESS STEEL IS BETTER BUT MUCH MORE EXPENSIVE. SUITABILITY OF OTHER METALS AND ALLOYS HAS NOT BEEN DETERMINED.

FROTH FLOTATION SEPARATOR

(NOMINAL CAPACITY: 3 TONS PER HOUR)

ASSEMBLY

U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL & INDUSTRIAL CHEMISTRY
WESTERN REGIONAL RESEARCH LABORATORY
M. J. COPLEY - DIRECTOR — ALBANY, CALIFORNIA
ENGINEERING & DEVELOPMENT DIVISION
W. D. RAMAGE - HEAD

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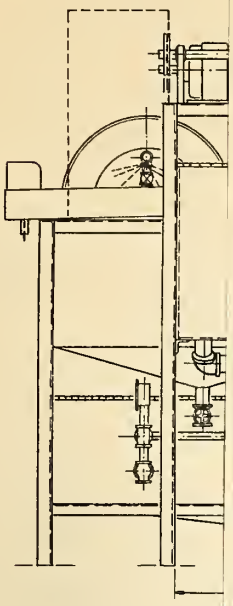
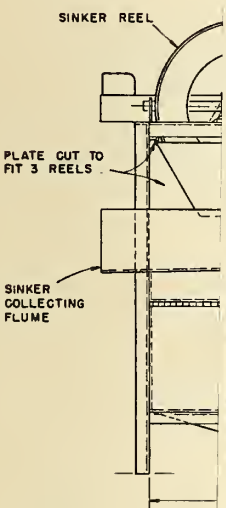
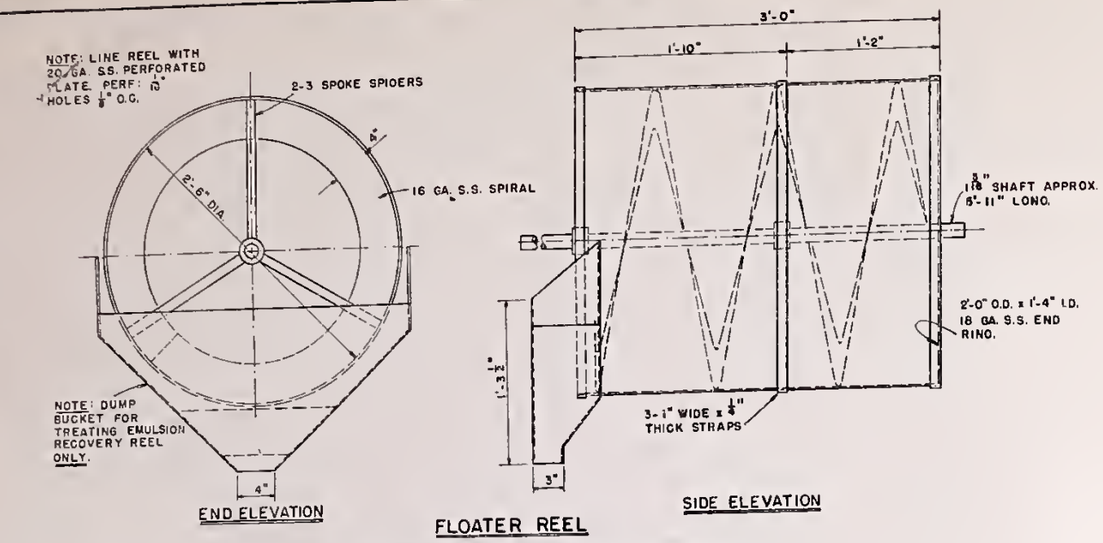
APPROVED A. M. Boudart			6/6/49	WR. REQ NO.
DES. BY A.M.N.	DR. BY M.OC.	CK. BY		DWG. O-234

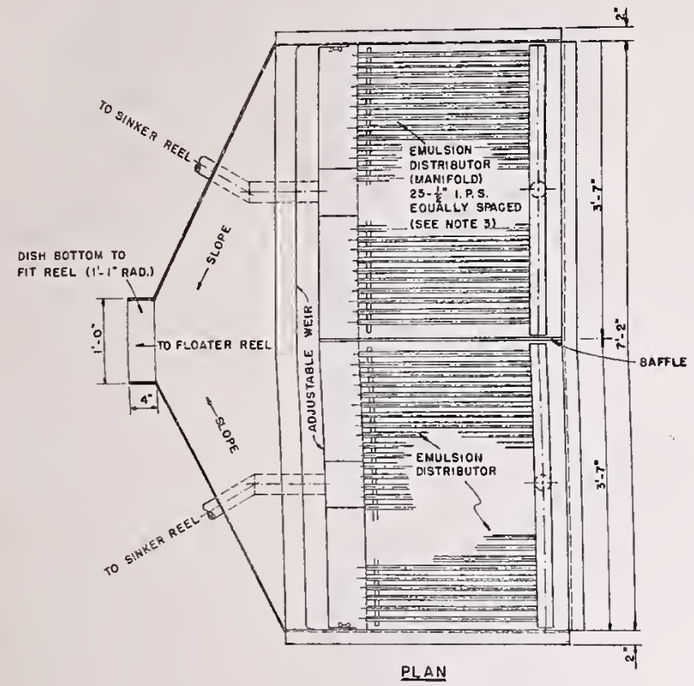



SINKER REEL
PLATE CUT TO FIT 3 REELS
SINKER COLLECTING FLUME



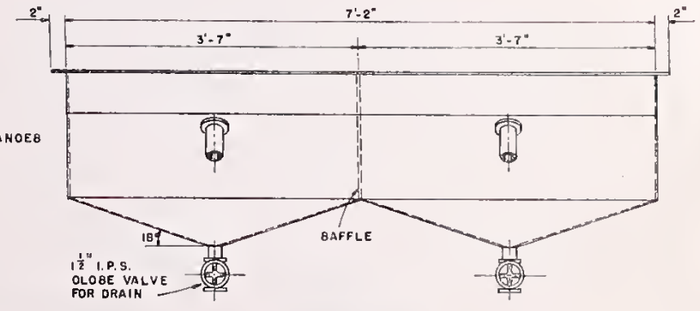
FLOATER REEL

1 REEL REQ'D. WITH 6" PITCH & 4" DEPTH (FLOATER REEL).
1 REEL REQ'D. WITH 7" PITCH & 4" DEPTH (TREAT. EM'L. RECOV. REEL)



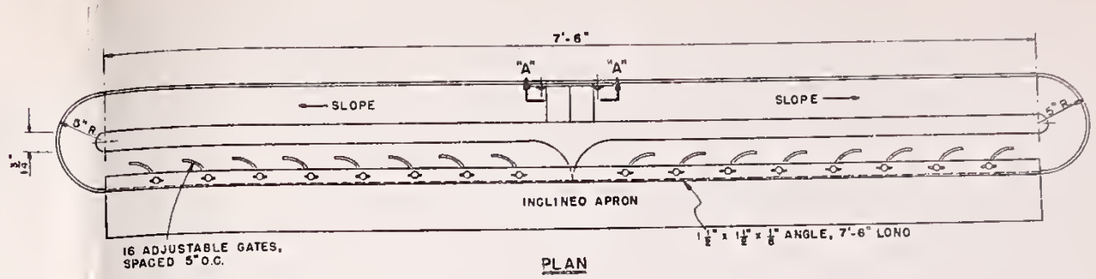
PLAN

SIDE ELEVATION

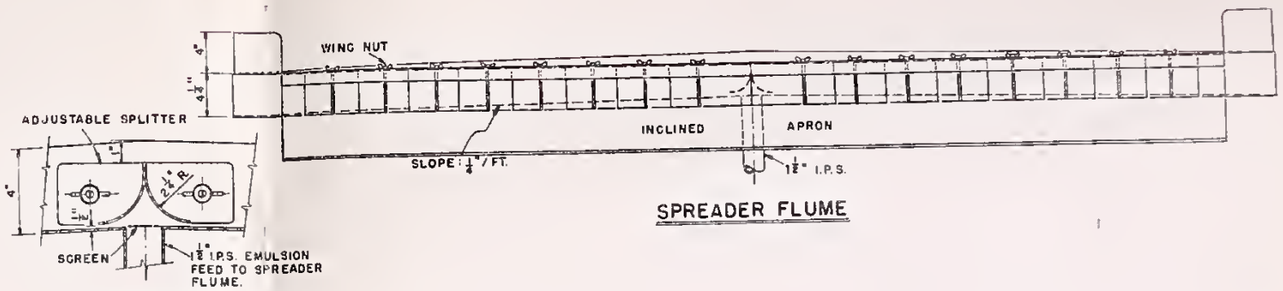


END ELEVATION

SEPARATION TANK
SCALE: 1" = 1'-0"

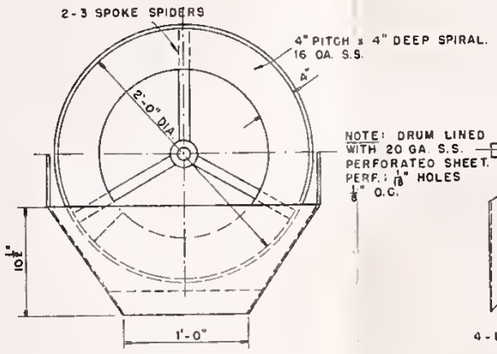


PLAN

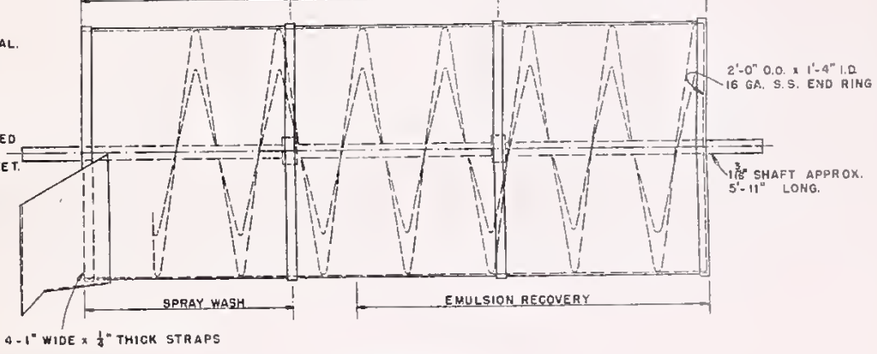


SPREADER FLUME

SECTION "A-A"
SCALE: 3" = 1'-0"



END ELEVATION



SIDE ELEVATION

SPLIT SINKER REEL

SCALE: 1 1/2" = 1'-0" UNLESS OTHERWISE NOTED

FROTH FLOTATION SEPARATOR

(NOMINAL CAPACITY: 3 TONS PER HOUR)

DETAILS

U. S. DEPARTMENT OF AGRICULTURE
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W. O. RAMAGE - HEAD

RECOMMENDED A. M. Neubert		DATE	SH. 2 OF 3 SHEETS
APPROVED A. M. Neubert		2/7/47	W.R. REG. NO.
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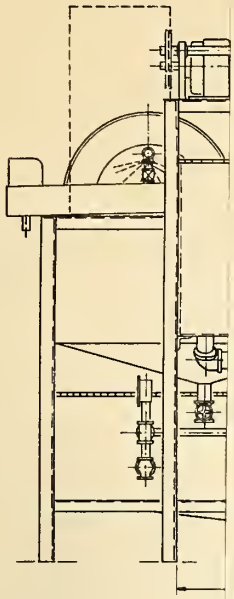
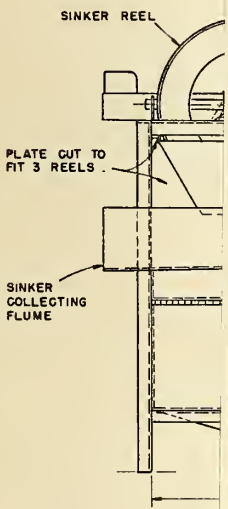
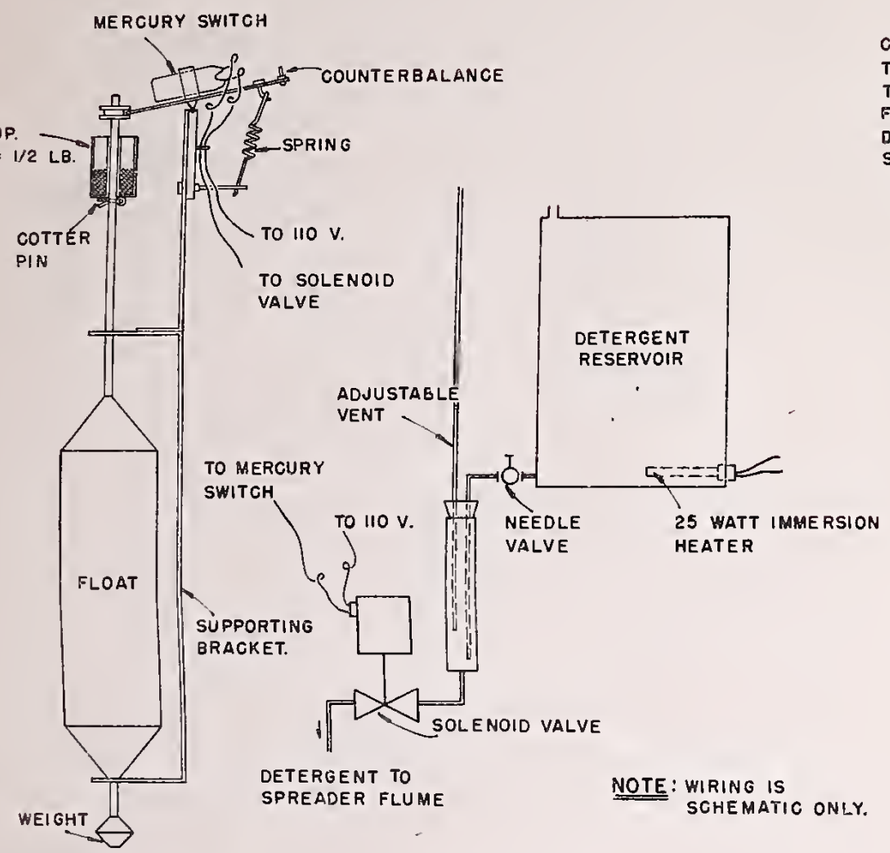



SINKER REEL
PLATE CUT TO FIT 3 REELS.
SINKER COLLECTING FLUME

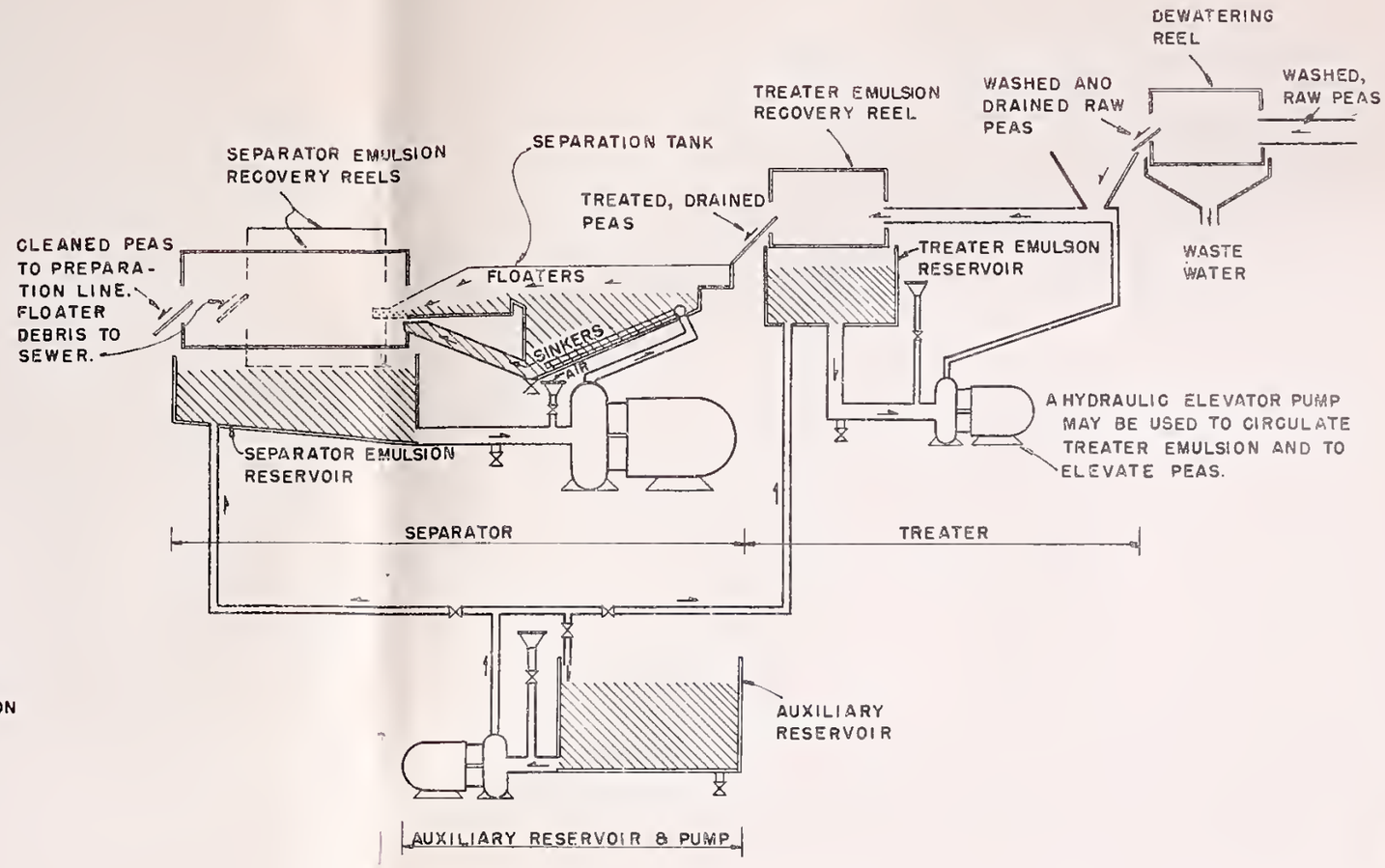
NOTE: PROVIDE HOUSING FOR SWITCH AS REQUIRED.



NOTE: WIRING IS SCHEMATIC ONLY.

SEPARATION REGULATOR WITH SPECIAL FLOAT SWITCH

3" = 1'-0"



SCHEMATIC FLOW DIAGRAM OF TREATER, SEPARATOR, & AUXILIARY RESERVOIR

FROTH FLOTATION SEPARATOR

SCHEMATIC FLOW DIAGRAM & SEPARATION REGULATOR

U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL & INDUSTRIAL CHEMISTRY
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